International Council for the Exploration of the Sea

C.M. 1977/B:1
Gear and Behaviour Committee

Administrative Report for 1976

ed. P. J. G. Carrothers

BELGIUM

(G. Vanden Broucke)

Comparative fishing trials were conducted with a double beam trawl and a conventional single-beam stern trawl in Liverpool Bay. Warp tensions were measured and catches noted with the result that adjustments to the taper rate were identified to improve the hydrodynamic shape of the net.

The effect of different leg systems on the behaviour of two types of semi-pelagic trawl was studied, and warp tensions in semi-pelagic pair trawls were measured.

The behaviour of pelagic pair trawls in the herring fishery was studied in relation to the weight of the ground rope, the number of floats on the headline, vessel speed, warp length and distance between the vessels.

Three experiments were conducted with single-walled set gill-nets for sole.

Certain technical aspects of electrical fishing apparatus were studied. A compact pulse generator has been developed and subjected to laboratory tests, and experiments have been conducted with shrimp and sole at sea.

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The noise generated by a shrimp trawl, by a bottom trawl and by a semi-pelagic trawl was recorded. Trawl rigging was modified to ascertain its effect on the sound generated.

Ship owners and fishermen have been contacted to obtain base data for the study on the effect of gas and oil pipe lines on fishing operations.

Fishing vessel studies were mainly concerned with conversion of side trawlers to stern trawlers, and were implemented on deep sea trawlers. The use of net drums improved gear handling. Also, advice on the use of net sounders and sonar was provided, and the introduction of the automatic feeding system for the shrimp rinsing and sorting machine in the Belgian fishery was further examined.

Various yarns and netting were tested for yarn strength, knot strength, mesh strength, mesh size, etc., mainly on request of industry. The effect of mesh load on mesh length was studied with the ICES mesh gauge, taking into account the fibre type, yarn construction and linear density, and whether the netting was single-or double-yarn. Various methods for measuring abrasion resistance of netting materials were also studied.

Work planned for 1977 includes:

1) Design of a double beam trawl based on results of earlier trials.
2) Design and use of a compact, battery-powered, under-water pulse generator.
3) Study and application of set gill-nets for fishing near wrecks.
4) Introduction of oval polyvalent trawl doors to the commercial fishery.
5) Field investigations of netting materials.

No work is planned immediately on fishing technology related to the harvesting of major, unconventional, living, marine resources as requested in C.Res. 1976/4:4

CANADA

(P.J.G. Carrothers)

Development of shrimp-trawling techniques has been conducted in Newfoundland, New Brunswick, Quebec and the Pacific Coast both to increase the catch per day and to reduce by-catch. In Newfoundland and Quebec, variations of separator trawl with twin cod-end have been tried with reasonable success to reduce by-catch of juvenile red-fish, and further optimization of this type of design is planned for 1977.

In New Brunswick, midwater trawls fished within 1 to 2 fms of the sea-bed have extended the usual, daytime, bottom-trawl fishery into a "round-the-clock" operation with remarkably low by-catch of juvenile red-fish. A variable depth sonar, for improved resolution at higher frequency in greater depths, is being developed to help find the shrimp, and an off-bottom trawl is to be tried in this fishery in 1977. On the Pacific Coast, Dutch, double-rigged beam trawls have been modified to 1 fm vertical opening for good shrimp catches with lower eulachon by-catch than is taken by the traditional otter trawl.

Development of improved acoustic counting and integrating techniques for fishery resource inventory continues as a tri-lab exercise involving coordinated activities in Newfoundland, Halifax and St. Andrews. An integrator has been added to the system for assessing stocks of schooled pelagic species. A dual-beam transducer and automatically variable bottom-echo rejection capability has been introduced for more discriminate groundfish counts. Improved software has been developed for separating and analysing single and multiple fish echos. More detailed information on echo strength as a function of fish species, size and aspect has been obtained in an effort better to understand echo variability and to improve calibration, and the automatic, sea-bed-referencing, towed camera vehicle continues to be developed for visual truthing of acoustic data. Echo strengths from invertebrate targets are being studied. Technical information on the present system is being formally documented.

Various round-haul nets (Scottish-, purse-, drum-, stern-seines) for small (10 - 18 m) inshore vessels are being developed in Newfoundland with considerable success for pelagic fish and cod to lengthen the fishing season and to up-grade traditional long-liners and set gill-netters for multi-purpose use. So far, purse-seining with power block has been most acceptable to the commercial fleet, but drum-seining with improved mechanics is to be tried again in 1977. Stern seining for herring and mackeral, both for inshore and for larger vessels, continues to be developed. A stern seine has been built for and set by one of the new Newfoundland, 20-m, multi-purpose stern-ramp vessels and will be fished in 1977. Also, an audio-visual slide presentation on stern seining and instruction on the use of sonar have been introduced for the Newfoundland fisheries.

Another experiment to improve the versatility of the Newfoundland inshore long-line vessels was a directed set gill-net operation for turbot in 180-200 fm water up to 70 miles from shore. These were unbuoyed nets, 50 fm long, set in fleets of 20. Reasonably clean catches of commercial size were obtained, and the nuisance by-catch of crab was considerably reduced by adding some buoyancy to the float line.

A technique has been developed to reduce fish-landing time and effort and to improve fish quality from decked long-line, trap and set gill-net vessels by dispensing entirely with pitch forks and,

instead, by layering the catch with ice on netting slings in the hold at sea and by lifting the catch ashore in these slings. This technique is sure to see increased application in 1977.

Following successful trials with round, cambered trawl doors on the Pacific Coast for multi-purpose, demersal-pelagic use, a modification to elongate the doors vertically by an insert into the horizontal diameter, has been made in an effort to improve lift-to-drag characteristics. The modified doors function properly and will be tried in the commercial fishery in 1977. Other modifications to groundfish trawls for the Pacific fishery are for higher opening and better operation on hard grounds.

The introduction of commercial automated long-lining is having its hey-and-grey days. The Newfoundland boats which tried it are now fishing set gill-nets, but there are plans to put improve long-lining equipment on a Nova Scotia vessel. The prototype of a simple baiting system for inshore boats being developed at Memorial University has been granted a U.S. patent, but the bait feeding mechanism requires further work.

The long-term engineering research project with groundfish trawls is entering its final reporting phase and will be succeeded by a multi-disciplinary study of techniques for fishery resource inventory, by both trawl-sampling and acoustic means.

DENMARK

(K. Popp Madsen)

The following investigations were continued in 1976:

1) Mesh selection experiments on cod with Nymplex 50-3/20 in the Baltic and the Sound.
2) Catch of cod and flatfish in bottom trawl in relation to salinity and oxygen content near the bottom in the Sound.
3) The catchability of Norway lobster has been related to oxygen content and temperature near the bottom in the eastern Kattegat.

FINLAND

(Veikko Sjöblom)

No gear and behaviour work was conducted in 1976.

FRANCE

(Marcel Portier)

En 1976, on a accompli dans le cadre d'un programme de coopération franco-soviétique entre l'I S T P M et le S E K B une mission d'essais et d'observations sous-marines d'engins de pêche à bord d'un navire de recherche soviétique. Cette mission a permis de compléter utilement des essais préalables de maquettes en bassin. En effet les modèles réduits de chaluts pélagiques, semi-pélagiques à 4 faces et fond avec différents types de panneaux (Süberkrüb, Portier/I S T P M, Morgère, Matrosov) ont d'abord été étudiés en bassin à des échelles variant du 1/20ème au 1/40ème; différentes mesures ont été effectuées ainsi que des observations sur le comportement des chaluts en fonction des réglages du gréement. Ensuite, à bord du "ZUND" (82 m. 2300 CV) dans les eaux africaines, on a réalisé des mesures et des observations sous-marines à bord d'un bathyplan, sous-marin remorqué transportant deux opérateurs.

Les résultats de ces travaux seront publiés ultérieurement, mais d'ores et déjà on peut signaler une analogie certaine dans le comportement des modèles réduits et des engins grandeur nature. Toutefois des écarts entre les forces agissant sur les divers éléments du train de pêche (panneaux et chaluts) du modèle et de l'original ont été décelés et nous incitent à approfondir nos connaissances dans l'application des règles de similitude hydrodynamique et principalement à évaluer l'influence du nombre de Reynolds sur le comportement des maquettes.

Dans le domaine du chalutage strictement benthique on a poursuivi la mise au point d'un chalut de fond à 4 faces commencée en 75. Les essais ont montré que ce chalut, utilisé avec des panneaux Morgère et un gréement simple comportant seulement deux langues entremises, présentait une ouverture verticale et un écartement aux pointes d'ailes importants ainsi qu'une bonne posée du bourrelet sur le fond.

De la même façon on a pu effectuer de nouvelles mises au point d'un chalut appelé semi-pélagique à 4 faces qui est en fait un chalut de fond à très grande ouverture verticale pouvant être utilisé soit avec des panneaux de fond et un gréement à fourches, soit avec des panneaux travaillant entre deux eaux. Les observations sous-marines ont montré avec plus de précision que le bassin, qu'il était difficile de poser le carré de ventre sur le fond. Ce défaut a souvent été reproché à ce chalut par ses utilisateurs français, principalement des pêcheurs méditerranéens et une modification de la face inférieure a été étudiée pour remédier à cet inconvénient.

Si les navires de pêche industrielle utilisent pour la pêche sur le fond des chaluts traditionnels ou à plus grande ouverture verticale grées avec de longues entremises et des bras, on constate l'importance de plus en plus grande prise par les chaluts de fond à grande ouverture et le gréement à fourche sur les bateaux artisans (bateaux de 15 à 25 m, 50 tonneaux de jauge brute et jusqu'à 500 CV de puissance.

Une expérience commerciale de pêche de la crevette profonde du Groenland a été entreprise. Le matériel utilisé se composant de chaluts de fond à grande ouverture verticale et de panneaux Mogère.

Pour le chalutage pélagique à un ou deux bateaux on a adopté des mailles de 1600 et 3200 mm à l'entêture. Des essais satisfaisants ont été effectués avec des chaluts comportant des cordages parallèles et une technique de calcul des longueurs des cordes a été mise au point.

On a également étudié des chaluts comportant de très grandes mailles en cordages à l'entrée : mailles de 4 - 5 - 6 - 7 et 8 m., et caractérisés par le fait qu'ils ne comportent pas de coutures, mais un assemblage maille à maille des différentes faces. Ces chaluts présentent un très grand pouvoir de filtration et une faible résistance à l'avancement. Leur pouvoir de pêche semble important.

Ces améliorations, ainsi que l'utilisation des tambours enrouleurs, rendent possible la pratique du chalutage pélagique à un ou deux bateaux aux unités de faible puissance. C'est ainsi que l'on note un développement important de cette technique dans les ports de la côte Atlantique, où elle s'oppose parfois sur les mêmes lieux de pêche aux métiers traditionnels (palangres, casiers, filets maillants). Le matériau utilisé pour la construction des filets et principalement des culs de chalut est en majeure partie le polyamide. Un peu de polyéthylène est utilisé dans la confection de certains chaluts de fond adaptés aux fonds très durs.

Sélectivité

Une étude de la sélectivité des chaluts artisans, utilisés pour la pêche du merlu dans le golfe de Gascogne, a été réalisée à bord du Roselys II (330 CV).

Le facteur de sélection moyen (3,9) ne s'éloigne pas de ceux trouvés par le THALASSA (800 CV) lors d'une campagne effectuée en 1974.

Dans les conditions de pêche rencontrées, la possibilité d'échappement semble toutefois plus grande avec une poche longue (Sf = 4,4).

L'influence de la longueur de la poche sur le facteur de sélectivité parait donc plus grande que celle de la puissance comparée des chalutiers.

Bassin d'essais

Le bassin d'essais de chaluts de Lorient (largeur 2,60 m., hauteur d'eau 1,70 m., à longueur pratique 14 m.) n'est pas ouvert au public, un perfectionnement du système d'homogénéisation de la veine d'eau s'est avéré nécessaire pour disposer d'un bassin utilisable pour des démonstrations aux professionnels, mais aussi pour effectuer des mesures sur les maquettes.

Senne à thons

Depuis plusieurs années maintenant nous effectuons des mesures sur les sennes équipant les nouveaux thoniers-senneurs lorsque ceux-ci effectuent leurs essais au large des côtes bretonnes. Il s'agit de mesurer la vitesse de plongée de la senne et de vérifier la tenur de la ralingue inférieure pendant le virage et la coulisse. Ainsi nous avons cette année, amarré six bathykymographes répartis sur toute la ralingue de la ralingue inférieure d'une senne de 1100 m. de long et de 140 m. de chute (mailles étirées). Ce filet en mailles de 50 mm de côté était lesté de 5,2 Kg/m sur 920 m et de 32 Kg/m sur 180 m dans la partie avant sous la poche. La vitesse moyenne de chute était de 11,4 m/mn; la profondeur maximale de 92 m a été atteinte en 10 mn au niveau du tiers antérieur de la senne.

Le rapport d'armement des sennes est en général de 0,80 (parfois un peu plus vers le milieu). La tendance actuelle est d'augmenter la hauteur des filets et à diminuer un peu la longueur pour obtenir des sennes de 1000 x 150 m.

Pêche électrique

Les études de la pêche électrique en mer menées à l'I S T P M sont désormais achevées, du moins au stade du laboratoire. Les résultats obtenus sur des sardines *Sardina pilchardus* (WALBAUM) et les caractéristiques du système de pêche par lumière, champ électrique et pompe aspirante, mis au point par l'I S T P M seront prochainement publiés.

GERMAN DEMOCRATIC REPUBLIC

(H. J. Fischer)

Preliminary trials were conducted with knotless,braided netting in bottom-trawl cod-ends on a stern trawler, including selectivity measurements. The netting showed high durability, stable mesh size, and good selectivity properties.

New construction of trawl doors for mid-water trawling on super-trawlers (high powered stern trawlers) has been completed and will be used first on "Superatlantik", which went into service in January 1977.

Scientific work continues to improve analytical methods for designing pelagic trawls. A method has been developed using a more realistic cross-section than the circular cross-section used previously.

Underwater television equipment has been built for the technical observation of fishing gear and to observe the behaviour of fish near trawls, and it has been used for the first time on a research vessel.

Apparatus has been constructed and tested in the laboratory for measuring the reflective properties of fish in an acoustic beam. It will be used to obtain data for developing hydroacoustic equipment and data processing procedures for the quantitative estimation of commercial fish stocks.

A mid-water pair trawl and corresponding fishing technology have been developed for high-powered stern trawlers, and feasibility of this gear and method has been demonstrated by trials at sea.

FEDERAL REPUBLIC OF GERMANY

(H. Bohl)

Gear Technology

In 1976, research on rope trawls for coastal and distant water fisheries was continued. Using short legs and heavy weights in combination with large four-panel-trawls, a considerable increase of the net opening compared with the traditional version of the trawl could be achieved. Furthermore, it could be shown by means of a multi-netsonde that the concentrating effect of the ropes on blue whiting is even greater than that of very large meshes (160 cm mesh length). An essential prerequisite for the handling of rope trawls is the existence of a net drum aboard the towing vessel. Rope trawls with four panels are already commercially used by many distant water trawlers, while those with two panels are applied to some extent by cutters.

Spherical otter boards for bottom and midwater trawling were further improved and tested in full-scale experiments. Due to their high spreading efficiency, these boards can be smaller than other types of otter boards. Moreover, they proved suitable on rough bottom and during great changes of the towing course. In addition to this field work, model wind-tunnel tests were conducted with different kinds of otter boards in order to obtain information on their lift and drag coefficients.

The forces acting on the warps during towing were measured in order to determine the breaking strength which is needed for avoiding gear losses even under extreme conditions.

Investigations on the relationship between water temperature and fish distribution were continued by means of a combined thermo-netsonde.

In order to facilitate the substitution of gear suitable for catching different species (e.g. cod/eel), the principle of modular construction was applied in the design of cutter trawls.

In model tests in the central Baltic, during 1976, different versions of rope trawl and various types of otter board (scale 1:4) were observed by multi-netsonde and by skin-divers from a chartered cutter of 14 m total length and 125 hp. It was demonstrated that the rope trawl is not less manoeuverable than a netting trawl, and that spherical otter boards are superior to the other types of otter boards tested.

Experiments with electrified beam trawls for catching flat-fish were continued in the German Bight. As in 1975, one of the trawls of the double-beam-rigged cutter was electrified. All tickler chains except one were removed from this gear to reduce the weight. The average weight of the soles caught by the electrified trawl was found to be 46 per cent higher than that of the soles caught in the conventionally rigged (heavy) gear. Further experiments will be conducted in order to determine the length and amplitude of pulses most suitable for the capture of soles.

Progress was made in the development of a shipborn data acquisition system. A new means of data transmission by frequency-shift-keying modulation of the signals proved successful even when the winches were running.

It should be mentioned that considerable effort was spent to solve the problems arising in connection with the detection and catching of krill and Antarctic fishes.

Net materials

All midwater trawls and about 92 percent of the bottom trawls manufactured in the Federal Republic are made of polyamide. The remaining 10 percent of the bottom trawls are made of plaited polyethylene yarns.

Research was continued to determine the cause(s) of the decreasing elasticity of mid-water-trawl netting yarns with use in fishing operations.

The cooperation with national and international bodies concerned with net materials and standardisation of testing methods was maintained.

Selectivity experiments

In 1976, a first attempt was made to collect selectivity data for saithe, but this attempt failed because at the time of the trials almost no fish of sizes within the selection range of the cod-end mesh were caught in the working area (Icelandic waters). The few data obtained do indicate a saithe selection factor of about 3.9. The experiment will be repeated in 1977.

As to the occurrence of meshed specimens in the redfish fishery off Iceland, it was found that the currently enforced minimum mesh opening of 135 mm (for redfish) does not cause any serious problems. This may be attributed to the fact that redfish of the length range exposed to meshing (mean length of meshed fish 41 cm) were scarcely represented in the stock.

Fish Behaviour

Observations of fish reaction during midwater trawling were continued by means of echo-sounding devices. In contrast to previous investigations, a higher sensitivity of Blue whiting to the gear was noted. This has to be taken into account in the development of adequate fishing methods.

ICELAND

(G. Thorsteinsson)

A few experiments were made to compare the selectivity of a Danish seine and a bottom trawl using the same mesh opening in the cod-ends. Both gears showed a similar selection on plaice whereas the cod selection proved to be superior in the Danish seine.

As part of the Icelandic effort to increase the cod-end mesh size in trawling, some comparative selectivity experiments were made on a 250 BRT side trawler and a 780 BRT stern trawler in order to determine a possible difference. The same cod-end (double PE 5 mm with big meshed chafer) was used in both experiments which unfortunately could not be conducted simultaneously. The selection factor for cod was 3.08 on the stern trawler but 2.98 on the smaller side trawler. In case of haddock the selection factor proved to be 2.97 on the stern trawler but only 2.60 on the small side trawler. This unexpected difference could be explained by greater fish girth due to plentiful food supply during the experiments on the small side trawler.

Intensified trials were made to search for new prawn grounds in deep water off the west, north and east coasts. Gradually the grounds off the north coast are being utilized by larger ships equipped with bigger trawls than previously used.

Some measurements were made on otter boards in operation using different angles of attack.

Effort has been made to introduce the ISO-standards dealing with netting technology. Preparations were made to publish some national standards in 1977.

IRELAND

(F. A. Gibson)

No gear and behaviour work to report for 1976.

NETHERLANDS

(J. G. deWit)

The geometry of a rope trawl was compared with a common midwater trawl of 1736 meshes (20 cm) circumference. Measurements were taken at 1000, 1200 and 1300 hp and at warp lengths ranging from 200 to 325 fathoms. The rope trawl design was derived from the above-mentioned midwater trawl. Later, the rope trawl design was changed in an effort to obtain a bigger trawl opening than that of the original midwater trawl.

Much attention was paid to reducing by-catch and to returning it to the sea in the best possible condition to survive. To this end, the electric stimulation of fish and shrimp has been further developed and the development of a catch-grader has been undertaken.

The work on electric stimulation remained directed to flatfish, eel (both in freshwater and in seawater) and shrimps. The main research aim was to improve and to modify the electric equipment to obtain better catches and better selectivity. The electric stimulation of fish and shrimps requires a much lower towing speed of the gear, so the by-catch suffers much less from sand and debris in the cod-end than when towed at 6 knots or more and has a much better chance to survive.

In order to reduce the damage to the by-catch held on deck, the catch-grader has been developed. It permits the whole haul to be kept in running seawater. A conveyor belt takes the fish gradually from tanks and the crew picks the fish they wish to retain from the conveyor belt. The discard fish pass overboard after having been out of the seawater for only a few seconds. A valuable side-effect of this equipment is that the crew can do its work of grading and gutting while standing upright.

Hydraulic transport of mussels has further been developed to a method for collecting mussels from the sea-bed. The mouth piece has been improved in order to minimize seabed disturbance and contamination of the mussels by seabed material. Hydraulic transport has also been used in the development of better methods for transferring mussels and mussel seed to the culture plots. Damage to the mussels and mussel seed has thereby been notably reduced.

NORWAY

(Steinar Olsen)

The basic studies of long lining started in 1975 were continued in April/May 1976 at the Finnmark coast. The effects on catch rates of hook distance and other gear parameters were studied, and the efficiency of monofilament long lines was compared with that the conventional type with the main line made of twisted multifilament. The development of a system for mechanized gear handling in the coastal small and medium vessel long line fisheries continued, and alternative system designs were evaluated. Development of artificial bait has continued with testing various kinds of stimulus carriers with regard to their texture, solubility and other characteristics. Associated with these technological investigations relevant basic fish behaviour studies in relation to

long lines were started, partly in tanks and partly in the open, with the aid of low-light underwater television.

Field tests on commercial vessels with a hydraulic gill net drum were carried out during the winter fisheries for cod in Lofoten and at the Finnmark coast. Functional test of a modified system and with gill nets rigged with a new float line were conducted in November/December.

Extensive commercial-scale fishing trials for tusk and ling with deep sea trips off the mid-west coast of Norway and off the Shetlands were discouraging. Subsequent work on traps has therefore been directed towards basic studies of fish behaviour in relation to traps and alternative designs of such traps.

A special study was carried out in the Barents Sea in September for the purpose of assessing the effects on cod and selectivity by the use of chafers of various mesh sizes and by the use of round straps.

Work on prawn sorting trawl was continued and a sorting panel installed in the belly of the trawl appears to be fairly effective. Similarly, observations on the behaviour of prawns and small cod in relation to a moving model trawl have been made in tank experiments in order to study the response of prawns and I-group cod to such a sorting panel.

Experiments were carried out with large sized meshes in a blue whiting trawl as a continuation of the work started in 1975 with rope trawls.

Sea tests of a computer display system for presentation of information on fish distribution and vessel/gear positions during trawling were started. Information about fish distribution and behaviour are obtained from sonar/echo sounder onboard the vessel and from a multi netsonde on the trawl.

Initial trials of a system for increased mechanization in the gear handling on coastal purse seiners were carried out in October/November. Results were very encouraging and further experiments are planned for 1977. Associated with this project were the first trials of using net of hexagonal meshes in a purse seine. In 1977 a full purse seine made of such netting will be tested.

Experiments with sound/food conditioning of large schools of saithe enclosed in small bays have been continued. Seasonal variation in their natural behaviour was observed.

Further work on the construction of an electric fish fence in salt water has been carried out.

Experiments have been undertaken in order to study avoidance and/or descendence of fish when vessels are passing, i.e. during echo surveying.

POLAND

(W. Cieglewicz)

No report received.

PORTUGAL

No results to report for 1976.

SPAIN

(R. Robles)

During 1976, two acoustic surveys were carried out by the Spanish Institute of Oceanography. The first of them, ACUSTICA DEMERSALES NW 76, was during May 1976 on the continental shelf of NW Spain. The main species studied were Hake, Horse Mackerel and Blue Whiting. Studies on fish distribution, both horizontal and vertical, and abundance estimation were the main targets of this cruise.

The second, PELAGOS 76, was carried out around the Canary Islands. The principal targets of this cruise was to chart the fish distribution and to determine the abundance of coastal pelagic species in the Canaries region. The main species studied were the Spanish Mackerel (*Scomber japonicus*), the Horse Mackerel (*Trachurus trachurus*) and the European Sardine (*Sardina pilchardus*).

The equipment used on both cruises consisted of two echo integrators, SIMRAD QM MK II and SIMRAD Scientific Sounder EK 38 S.

SWEDEN

(A. Lindquist)

Experiments with otter boards constructed by Mr. Karl-Hugo Larsson of Stockholm were performed in April 1976 in the Gullmar fjord with the fishing vessel "Westero" to study the economy of fishing.

Development of a combination trawl with otter boards for both pelagic and bottom trawling was initiated. Experiments were made with the R/V "Argos" in September to study technical functioning.

Trials with a Danish trawl for whitefish were made on board the Swedish fishing vessel GG 36 "Åsa" in October.

Experiments with propeller nozzles were conducted on board the fishing vessel GG 575 "Tudor" to study technical functioning, economy and noise repression.

All work was in cooperation with the Chalmers Technical University, Goteborg.

UNITED KINGDOM

Fisheries Laboratory, Lowestoft (G.P. Arnold)

The analysis of the reactions of acoustically tagged plaice to the Granton trawl recorded on sector-scanning sonar film has continued. No work has been done this year on the effect of a door-to door tickler chain on the efficiency of the trawl but further cruises are planned for 1977.

Studies of plaice migration have continued, using a midwater trawl to make paired hauls of 3 hr duration on consecutive northerly and southerly tides off the East Anglian coast. The catch ratios in autumn and winter are reversed indicating that both prespawning and postspawning plaice use selective tidal stream transport on migration.

Microminiaturization techniques have been perfected for the construction of transponding acoustic tag circuits and a small compass tag has been developed which can be attached to plaice of 40-50 cm length. Work is in progress on a multichannel miniature tag which will telemeter the compass heading of the fish and various physiological parameters back to the tracking ship.

Considerable effort has been devoted to fish target strength measurements to improve acoustic estimates of fish abundance. Some preliminary work has been done with caged mackerel and an in situ technique has been developed for measurements with blue whiting. A transducer is lowered to within 20 m of a fish aggregation, which may be 400 m deep; single fish echoes are then readily discernible and are recorded for subsequent statistical analysis. Acoustic surveys have been made of mackerel stocks off south-west England, of blue whiting to the west of the UK and an exploratory survey has been made of gadoids off the north-east coast of England.

White Fish Authority, Industrial Development Unit, Hull (J.F. Foster)

Trials were carried out with an Engel 630 x 80 cm mesh trawl to measure the power required to tow the gear and to describe its behaviour during acceleration and deceleration. Ship speed, shaft power and warp tension were measured in addition to net gape and door and wing end spread.

The Balta two panel demersal trawl for vessels with a power greater than 900 kW has been under commercial evaluation by selected ships in the distant water trawler fleet. Assistance has also been given to the Marine Laboratory, Aberdeen, with the introduction of its 4 panel demersal trawl into the English middle and distant water trawler fleet.

Work has continued on the development of automatic baiting and detachable snood systems for long lining and the performance of Japanese squid jigging machines has been further evaluated.

The flume tank in Hull has now been in service for 12 months without developing any major faults. A comprehensive range of models has been constructed of the demersal and pelagic trawls used by the distant water fleet. The range of models of trawls used by the inshore fleet is to be extended next year.

Marine Laboratory, Aberdeen (J.J. Foster)

(a) Gear Technology

The Four Panel Trawl continued to dominate the demersal trawling programme during 1976. The information "feed back" now coming from commercial enterprises, who have been fishing the gear over a period of time, brought to light particular aspects of the gear performance which required further laboratory investigation.

During the year both comparative fishing and instrumented trials were mounted on research and commercial vessels. The effect on the gear geometry of a shortened headline and groundrope was investigated to extend the availability of the gear to vessels where these are critical factors in gear handling.

The first TV films were successfully made of the behaviour of fish in the path of the Four Panel Trawl and further development of a wet towed vehicle and the new (SITCON) underwater camera have resulted in some new information of the ways in which trawl gears catch fish. Generally the behaviour is similar to that observed and described in previous studies of the seine net. Results include continuous illustrations of the generation of and the effect of the sand cloud thrown up by the trawl door. These films have already demonstrated to fishermen in a direct way the importance of fish behaviour during capture.

Experimental trials with Four Panel Trawl models were conducted in the White Fish Authority flume tank and comparisons made between the model and full scale results.

The engineering development of the Marine Laboratory "Delagic" trawl was completed. This trawl is similar to a large pelagic gear but it has an improved ability for being fished in contact with the sea bed. Versions of the Delagic Trawl are available for 200, 600 and 1,000 HP vessels. During trials at sea the Delagic gear has been used with different types of otterboard. The standard Suberkrub board is recommended since it was shown to be the most effective in controlling net depth although limited in mechanical strength. In other trials the performance

of the Delagic gear as a pair trawl was investigated and the gear was shown to be equally effective in this role.

Work was completed on the design and construction of otterboards which incorporated rotor devices to control the horizontal position of a pelagic trawl. Sea going trials of this equipment have had to be postponed through lack of available sea time.

Work has continued on more accurate theoretical methods for predicting the performance of full scale gears under commercial fishing conditions. Wind tunnel tests on model otterboards were carried out to determine how the orientation of the otterboard influences the hydrodynamic forces. These results have started to be applied in computer programs which model the dynamic behaviour of a trawl gear.

(b) Electrical Fishing

Studies of the behaviour of flatfish and pink shrimps in electric fields have been successfully carried out. Encouraging results were obtained from the work on flatfish. This was directed to the development of fixed underwater electric barriers as simple means of fencing large bodies of sea water. The investigation of shrimp (Pandalus montagui) was aimed at obtaining basic information on their activity and at assessing the value of electrifing shrimp fishing gears. Work on the electrified beam trawl was completed, indicating that an electrical system could work as efficiently as chain ticklers on flatfish, but no firm conclusions were obtained on selectivity. Development of an electrical system for an ottertrawl was begun and valuable experience was gained. Physiological experiments on flatfish muscle have demonstrated conclusively the new finding that swimming muscle is directly stimulated resulting in anodic attraction in both pulsed and direct current electric fields. Investigation of the physiological basis of fish reaction to electrical stimulation was continued.

(c) Fish Behaviour Studies

The main effort during 1976 has been aimed at investigating means of improving the efficiency of the long-line. A range of synthetic and reconstituted baits, made from cheap readily available materials, suitable for use in an automatic baiting machine, have been developed and tested. Baits produced in the laboratories and by commercial concerns have been tested and compared both in the laboratory and at sea. At the same time theoretical studies

have been carried out on various aspects of hook and line design. The efficiency and selectivity of hooks of different sizes and types have been compared experimentally. This work is still in progress.

In association with the long-lining work, investigations have been carried out in the laboratory into the sensitivity of fish to various attractive chemical stimuli. Results show that cod are sensitive to extremely small concentrations of certain amino acids. Investigations have also been made of the factors controlling the rate of feeding of fish in the sea, with special attention being paid to the selection of prey of different size and type by the cod.

Study has continued on the natural movements of cod, concentrating particularly on rhythmic changes in the activity of cod with tide and time of day. Parallel studies of the activity of prey organisms have also been conducted. To help this work the fish tracking system has been developed further and interfaced to a small computer.

During the year further investigations have been made of the visual capacities of fish and especially of the sensitivity of cod to light of different colours. This work has enabled much more precise statements of the visual performance of the fish under various conditions in the sea to be made. These studies have also extended to the effects of object size upon visibility. The work is not only important in considering the ability of fish to see baits of different colour and size, but also in predicting how well fish can see fishing gears.

Studies of the hearing ability of fish were aimed at determining the ability of fish to discriminate sound source direction and showed that cod - unlike man - has very good directional sensitivity in the vertical plane. The hearing ability of other species has also been intensively investigated.

An up to date survey of knowledge of fish swimming performance and behaviour was prepared. Small herring were examined and their swimming performance measured. A new TV camera was developed for measurement of swimming power in fish. This apparatus is now available for experimental work and will be used to fill in the remaining gaps in information of swimming performance.

(d) Sonar

Fish surveys have continued to be based on the echo integrator constructed in the Marine Laboratory, since delays of at least a year have occured in the commercial production of these instruments. The combination of the Simrad EK38 sounder, with the Aberdeen type of towed transducer, has proved to be effective over a wide range of weather conditions.

Surveys were carried out for Blue Whiting early in the year, and this included intercalibration with the MAFF research vessel "Cirolana". Sprat surveys were carried out in summer, when the mixture of species made assessment more difficult than in previous years, and on winter sprat in the Moray Firth, giving an estimate of 40,000 tons for the area of survey.

Fundamental work continued on the acoustic characters of fish, which determine the interpretative constants in practical fish surveys. The operation, on Loch Hourn, was concerned with cod, haddock and whiting.

Considerable advances have been made with techniques and the results are the most comprehensive yet obtained on our standard working frequency of 38 kHz. It is clear that because of behavioural and adaptive characteristics of fish, the obtaining of truly representative acoustic constants calls for prolonged experiments, at least in relation to physoclists.

U. S. A.

(Keith Smith & Glade Woods)

There are two parts to this report, the first being concerned with activities of the Fisheries Research Centers of the U.S. National Marine Fisheries Service and second with projects of the University "Sea Grant" Program.

NATIONAL MARINE FISHERIES SERVICE

Selective Pollock Trawl Development

A major impact of the massive multi-national trawl fisheries for groundfish in the eastern Bering Sea has been the destruction of non-target species such as halibut and crab. Northwest and Alaska Fisheries Center (NWAFC) fishing gear specialists have developed various modifications to commercial trawls and rigging in an effort to solve this problem. In 1976 under the auspices of the International North Pacific Fisheries Commission and in cooperation with Japan and Canada, a joint experiment was conducted in the Bering Sea aboard four large, independent Japanese stern trawlers equipped with a newly-developed off-bottom trawl designed to minimize the incidental catch of halibut and crab. Results of these tests demonstrated that the incidental catch of non-target species can be reduced substantially with no adverse effect on catches of the target species-pollock (*Theragra chalcogramma*).

Trawl Mensuration Gear

An "acoustic-link" trawl mensuration system for measuring the openings and performance of otter trawls has been developed at NWAFC. Sea trials were conducted aboard NOAA and commercial fishing vessels in 1976. The system is currently in use in conduct of bottom-fish surveys in western Gulf of Alaska.

LANDSAT Menhaden and Thread Herring Investigation

A satellite marine resource investigation was conducted with the government and industry in 1975 and 1976. The objective of the investigation was to demonstrate and verify the applicability of satellite (LANDSAT) remote sensing for enhancing the management and utilization of coastal fishery resources in the northern Gulf of Mexico. Menhaden and thread herring were selected as target species in the study area. Correlations are being developed between the distribution of these resources and oceanographic data measurable from aerospace platforms, i.e., satellites. Currently, the investigation has demonstrated that the distribution of menhaden can be inferred from LANDSAT data with accuracies approaching 90%. A near real-time demonstration experiment conducted in July 1976 resulted in the conclusion that satellite data could be used to support industrial fishing operations.

Trawl-Door Salinity, Temperature, Conductivity (STC) Instrument

The NMFS is developing a trawl-door STC instrumentation system for recording environmental parameters in concert with trawl survey operations. The prototype system utilizing "state-of-the-art" electronics was designed in 1976 and will be field tested in 1977.

Remote Underwater Fisheries Assessment System (RUFAS) Development

RUFAS design modifications were implemented to improve the operational handling, vehicle performance and surface-to-subsurface telemetry capabilities. The modifications will allow easier operation for the ship's operator. RUFAS is scheduled for an assessment survey of crabs, clams, and fishery resources in the eastern Bering Sea.

Shrimp Separator Trawl

Development of a shrimp separator trawl for the Gulf of Mexico continued with significant progress. Several different configurations of the basic separator panels were tested, including a new design of a trash discard chute. In addition, studies surrounding a new fish barrier approach were initiated. Based upon 1976 field test analyses, the best combination of separator design characteristics will be incorporated into a single trawl for testing during 1977.

Sea Turtle Conservation Shrimp Trawl

Initial design concept studies were conducted in 1976 to outline a trawl design approach which can eliminate capture of sea turtles in shrimp trawls. Various separator panel techniques have promise for eliminating a significant portion of the sea turtle capture in shrimp trawls.

Bottom-Fish Survey Trawl

Development, testing and evaluation of a new standard trawl for conduct of bottom-fish survey off the northeast coast of the U.S.A. was completed. The new trawl, based upon a Yankee No. 41 design, provides headrope height x wing-spread openings of 14 feet x 38 feet. This is compared to openings of 9 feet x 34 feet of the older standard Yankee No. 36 survey trawl.

Automatic Data Logging System

The final design of a Digital Data Logging System (D-DAS) for use aboard the fisheries research ship ALBATROSS IV and other NOAA fisheries ships has been completed. All components have been received, assembled, and given laboratory test-trials preliminary to installation in the vessel. The system is capable of recording, on magnetic tape, up to 99 parameters at a repetition rate of 1/10 second or any longer period as desired. Initially, ship operating parameters (position, course, speed, etc.), meteorological observations, and standard hydrographic observations (water temperature, salinity, depth) will be recorded. Additional sensors can be included as they are acquired and installed.

Hydroacoustic Research, NMFS-NOAA

The Northwest and Alaska Fisheries Center, Seattle, WA, successfully completed field tests of a portable, van-contained, computerized acoustic data-acquisition system. The system utilizes a unique dual-beam method to estimate the in situ target strength of insonified fish aggregations. Valid target strength measurement permits conversion of integrated fish biomass estimates into absolute densities. This hydroacoustic assessment system provides new capability for estimating the abundance of off-bottom and midwater fish populations.

The southeast Fisheries Center, La Jolla, CA, continued work with side-looking sonar for detection and measurement to derive schooled-fish biomass. Substantial effort was directed to the isolation and quantification of sampling biases. In 1976, a close-grid survey was replicated five times over a portion of the Southern California Bight, as part of an effort to examine the interaction between gamefishes and forage-fishes. An acoustic-trawl survey of the northern anchovy (*Engraulis mordax*) off the Washington-Oregon coast is scheduled for July 1977.

Progress in the problem of species identification is being made along three lines: Improvement in the technology of trawl sampling; integration of the use of free vehicle cameras into survey designs; and inference of fish swim-bladder size from frequency dependence of echo-resonance from fish schools.

The Northeast Fisheries Center, Woods Hole, MA, continued cooperative investigation with ICNAF countries to more fully define the nature, values, and characteristics of echo-returns from certain identified species of fishes compared to echo-returns from physical targets of known back-scattering characteristics. In furtherance of this effort, U.S. government and contractor personnel (C. S. Draper Laboratory) joined scientists of the U.S.S.R. aboard the R/V KHRONOMETER for a 17-day acoustic research voyage off the northwest coast of Africa in May 1976. A jointly-authored U.S.A.-U.S.S.R. report on the conduct, results and analysis of the voyage was completed.

SEA GRANT UNIVERSITY PROJECTS

An Improved Trawl-Door Hook-up System (Mr. Arthur B. Clifton, Massachusetts Institute of Technology)

Development of an improved trawl-door hook-up system for use aboard trawlers. The present methods used are hazardous and time-consuming. A design will be worked out aimed towards safety and efficiency. A prototype system will be built and its performance evaluated by tests aboard local fishing vessels.

An Improved Towing-Block for Side Trawling (Professor Steven Loutrel, MIT)

A successful design has been achieved and performance during testing was favorable. Enthusiasm from within the fishing industry has been such that funds have been provided for building ten blocks for distribution throughout New England. Results from the use of these blocks and previous prototypes will be used in continued design optimization.

An Improved Trawl Board for the New England Fishing Fleet

(Professor John Kim Vandiver, MIT)

A viable alternative to the present trawl board will feature improved efficiency, greater durability, and ease of handling. An uncomplicated, easy-to-manufacture design can be cost-competitive with existing boards. The adoption of the improved design will allow the fisherman greater catch per fuel dollar and greater catch per unit of capital cost.

Bottom Trawl and Otter Board Performance Study (Capt. Geoffrey Motte, Univ. of Rhode Island)

Purpose is to determine the engineering performance of trawl doors for optimum operation, to determine the drag caused by trawl doors, footrope and net interaction with seafloor sediments, and to present a total summation of forces generating drag of an otter trawl by both hydrodynamic and frictional effects.

Hard Bottom Net (Bert Hillier, URI)

Purpose is to construct a high-opening trawl that can be fished on a very rough bottom and capable of being towed by the smaller 100 to 200 horsepower boats.

Underwater TV Surveillance of Fishing Gear (Robert Taber, URI)

Purpose is to develop a towed electronic platform which will allow skippers to observe gear performance through the use of a camera attached to the end of a 40 foot mast which will beam pictures to an on-board TV monitor.

Experimental Bottom Pair Trawling (Robert Taber, URI)

Purpose is to determine the technique's effectiveness in trawling for schooling species, including squid.

U. S. S. R.

(A. Treschev)

Improvement of fishing techniques to depths greater than 1000 m, selectivity of trawl cod-ends and possibilities to improve long-lining in the Barents Sea were studied from research vessels. The behaviour of cod, grenadier, redfish, capelin and polar cod under natural conditions in front of trawls was studied during cruises of FRV "Perseus III", FRV "Odysseus" and FRV "Artemide" in the Barents Sea and the Northwest Atlantic. Hydrostate "Sever-1", Automous submersible "Sever-2", underwater photographic cameras and hydroacoustic fish-detecting devices of Soviet and Norwegian manufacture were used for these observations. The effect of characteristic vertical migration of cod, polar cod and capelin on their accessibility to hydroacoustic instruments and fishing gears for abundance assessment was studied, and the abundance of cod, capelin and grenadier was estimated by instrument. New data on the behaviour of polar cod and redfish were obtained.

The selectivity of bottom trawls with 90-, 100-, and 110-mm mesh cod-ends for river flounder and the selectivity of bottom trawls

with 20- and 24- mm mesh cod-ends and pelagic trawls with 20- mm mesh cod-end for Baltic sprat were studied. Investigations begun in 1975 on the rate of traumatism and survivability of sprat escaping through the mesh of a pair-trawl cod-end were continued.

All fishing gears used in 1976 were made of Capron polyamide fibres.